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INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 7 : H04N 7/081, 7/088

A1

(11) International Publication Number: WO 00/35195

(43) International Publication Date: 15 June 2000 (15.06.00)

(21) International Application Number: PCT/EP99/09204

(22) International Filing Date: 24 November 1999 (24.11.99)

(30) Priority Data:
98204138.6 8 December 1998 (08.12.98) EP

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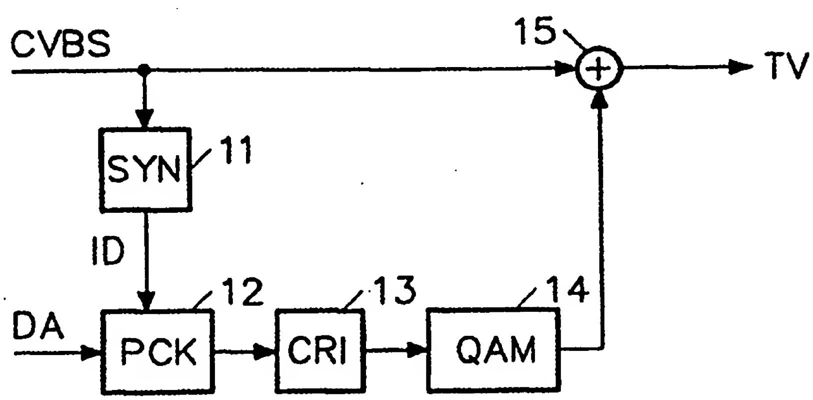
(81) Designated States: AU, JP, European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE).

Published

With international search report.
Before the expiration of the time limit for amending the claims and to be republished in the event of the receipt of amendments.

(54) Title: DATA TRANSMISSION IN A TELEVISION SIGNAL USING QUADRATURE AMPLITUDE MODULATION



(57) Abstract

Method and system for transmitting data in lines of a video signal. The data is packetized (12), provided with a clock-run-in sequence (13) and quadrature amplitude-modulated (14), using a carrier (f_c) which is located in the middle of the video bandwidth. The modulated data signal is then inserted (15) in selected video lines. In the preferred embodiment, QAM-16 is used so that data can be transmitted in the vertical blanking interval of a television signal at a higher bit rate (approximately 16 Mbit/s) than conventional teletext (6.9 Mb/s). Optionally, QAM-64 or even QAM-256 may be used to obtain a bit rate of approximately 24 or 32 Mbit/s, respectively.

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DATA TRANSMISSION IN A TELEVISION SIGNAL USING QUADRATURE AMPLITUDE MODULATION

FIELD OF THE INVENTION

The invention relates to a method and an arrangement for transmitting data packets in video lines of a television signal.

BACKGROUND OF THE INVENTION

A method of transmitting data in video lines of a television signal is generally known as teletext. In known teletext systems, the data is accommodated in a television line in the form of a non-return-to zero (NRZ) signal. The maximum bit rate in such a transmission system is restricted. For example, in PAL television systems having a video bandwidth of 5 MHz the teletext bit rate is approximately 6.9 Mb/s.

OBJECT AND SUMMARY OF THE INVENTION

It is an object of the invention to provide a data transmission method with a higher bit rate.

To this end, the method is characterized by quadrature amplitude modulating each data packet, using a predetermined carrier frequency which is located within the baseband video bandwidth of said television signal, and inserting said quadrature amplitude-modulated data packet in selected video lines of the television signal which are not used for video signal transmission. Preferably, the carrier frequency is substantially half the baseband video bandwidth of the television signal.

The corresponding method of receiving data packets comprises the step of quadrature amplitude-demodulating said data packets.

BRIEF DESCRIPTION OF THE FIGURES

Fig. 1 shows schematically an arrangement for transmitting data in accordance with the invention.

Fig. 2 shows a schematic diagram of a quadrature amplitude modulator.

Figs. 3-5 show diagrams to illustrate the operation of the arrangement which is shown in Fig. 1.

Fig. 6 shows schematically an arrangement for receiving data in accordance with the invention.

Fig. 7 shows a schematic diagram of a quadrature amplitude demodulator.

DESCRIPTION OF A PREFERRED EMBODIMENT

Fig. 1 shows schematically an arrangement for transmitting data in accordance with the invention. The arrangement receives a conventional composite video and blanking signal CVBS and a data signal DA. The transmitter includes a sync processing circuit **11** which identifies the video lines that are used for data transmission. Any line of the video signal may be used for this purpose. Usually, they are selected lines in the vertical blanking interval. The identification signal ID generated by the sync processing circuit **11** is applied to a packetizing circuit **12** which receives the data DA to be transmitted and creates packets of, for example, 800 data bits at a bit rate of, for example, 16 Mbit/s. The data packet is applied to a clock-run-in inserter **13** which places a predetermined clock-run-in (CRI) bit pattern in front of the packet. The packet including the CRI is then quadrature amplitude-modulated in a quadrature amplitude modulation (QAM) circuit **14**. The modulated data packet is subsequently inserted in the selected video line by an adder **15**.

Fig. 2 shows schematically a more detailed diagram of the quadrature amplitude modulator **14** which is here assumed to be a QAM-16 modulator. The modulator comprises a symbol generator **141** which divides the data packet into successive series of 4 data bits, and creates two 2-bit symbols S_i and S_q for each series. Each symbol is represented by a predetermined signal amplitude. More particularly, an amplitude -3 represents data bits "00", an amplitude -1 represents "01", an amplitude +1 represents "10", and an amplitude +3 represents "11". As shown in Fig. 3, there are 16 combinations of symbols S_i and S_q. Each $\{S_i, S_q\}$ pair of symbols in Fig. 3 represents one series of 4 data bits.

The sequences of symbols S_i and S_q are subjected to low-pass filters **142** and **143**, respectively, preferably square-root Nyquist filters. The filtered sequences are subsequently modulated on respective carriers having a frequency f_c by respective multipliers **144** and **145**. The carrier frequency is substantially half the video bandwidth, for example, f_c=2.5MHz. The symbols S_i are modulated on an in-phase carrier. The symbols S_q are modulated on a carrier, the phase of which has been shifted by 90° through a phase shifter **146**. The resultant in-phase signal I and quadrature signal Q are added by an adder **147** and processed by a post-processor **148**. The post-processor **148** scales the modulated signal and shifts its DC level in such a manner that the output signal complies with the relevant television

standard (PAL or NTSC). The modulator **14** is preferably implemented as a digital processing circuit operating at a 13.5 MHz line-locked frequency. The 2.5 MHz carrier frequency ($\frac{5}{27}\times 13.5$) and the 4 MHz frequency for forming the symbols ($\frac{8}{27}\times 13.5$) can easily be derived from said frequency.

Fig. 4 shows a line of the television signal with data. Numeral **41** denotes a data packet with 800 bits of QAM-modulated data, numeral **42** denotes the clock-run-in, numeral **43** denotes the horizontal synchronization pulse. The function of the clock-run-in is to assist a receiver in regenerating the carrier f_c with sufficient phase accuracy. To achieve this, the clock-run-in is preferably an alternating sequence of diagonal symbol pairs such as the symbol pairs {3,-3} and {-3,3} (numerals **31** and **32** in Fig. 3). Fig. 5 shows the frequency spectrum **51** of the quadrature-modulated data signal.

Fig. 6 shows schematically an arrangement for receiving data in accordance with the invention. The arrangement receives the television signal and applies it to a quadrature amplitude demodulator **61** and a sync separation circuit **62**. Optionally, the signal is also applied to a conventional television receiver **63**. The sync separation circuit **62** identifies the lines in the vertical blanking interval and activates the demodulator **61** during these lines. After demodulation, the data DA are further processed by a data processor **64**, for example, a personal computer.

Fig. 7 shows a schematic diagram of the quadrature amplitude demodulator **61**. The demodulator comprises a pre-processor **611** which receives the television signal and the signal ID identifying the vertical blanking interval. The pre-processor removes the DC component and performs automatic gain control.

The pre-processed signal is applied to a clock regeneration circuit **612** and multipliers **613** and **614**. The clock regeneration circuit **612** regenerates the carrier frequency f_c (2.5 MHz) and a sample clock f_s (4 MHz) in response to the clock-run-in CRI. The multipliers **613** and **614** multiply the QAM data signal by an in-phase component and a quadrature phase component of the regenerated carrier f_c, respectively. The latter component is obtained by means of a 90° phase shift of the regenerated carrier in phase shifter **615**. The symbols S_i and S_q are reconstructed by low-pass filtering the multiplied signals using square-root Nyquist filters **616** and **617**. Analog-to-digital converters **618** and **619** convert the symbols back into the original data bits DA. The demodulator **61** is preferably implemented as a digital processing circuit operating at a 13.5 MHz line-locked frequency.

With the QAM-16 modulation system described above, the bit rate of 16 Mbit/s is approximately 2.3 times the bit rate of a conventional teletext system. In cable systems having a good signal-to-noise ratio, it is also possible to use QAM-64, in which the input data at a bit rate of 24 Mbit/sec (3.5 times the conventional bit rate) is divided into series of 6 bits, or even QAM-256 in which the input data at a bit rate of 32 Mbit/sec (4.6 times the conventional bit rate) is divided into series of 8 bits.

In summary, a method and a system for transmitting data in lines of a video signal are disclosed. The data is packetized (12), provided with a clock-run-in sequence (13) and quadrature amplitude-modulated (14), using a carrier (f_c) which is located in the middle of the video bandwidth. The modulated data signal is then inserted (15) in selected video lines. In the preferred embodiment, QAM-16 is used so that data can be transmitted in the vertical blanking interval of a television signal at a higher bit rate (approximately 16 Mbit/s) than conventional teletext (6.9 Mb/s). Optionally, QAM-64 or even QAM-256 may be used to obtain a bit rate of approximately 24 or 32 Mbit/s, respectively.

CLAIMS:

1. A method of transmitting data packets in video lines of a television signal, characterized by quadrature amplitude-modulating (14) each data packet, using a predetermined carrier frequency (f_c) which is located within the baseband video bandwidth of said television signal, and inserting (15) said quadrature amplitude-modulated data packet in selected video lines of the television signal which are not used for video signal transmission.

2. A method as claimed in claim 1, wherein said carrier frequency is substantially half the baseband video bandwidth of the television signal.

3. A method as claimed in claim 1, wherein each data packet includes a clock-run-in sequence formed by an alternating sequence of diagonal symbols (31,32) in the (I,Q) space of the modulated signal.

4. A method as claimed in claim 1, wherein said video line is a line of the vertical blanking interval of the television signal.

5. A method as claimed in claim 1, wherein said quadrature amplitude modulation is QAM-16, QAM-64 or QAM-256.

6. A method of receiving data packets accommodated in video lines of a television signal, comprising the step of quadrature amplitude-demodulating (61) said data packets.

7. An arrangement for transmitting data packets in video lines of a television signal, characterized in that the arrangement comprises a quadrature amplitude modulator (14) for quadrature amplitude-modulating each data packet, using a predetermined carrier frequency (f_c) which is located within the baseband video bandwidth of said television signal, and means (15) for inserting said quadrature amplitude-modulated data packet in selected video lines of the television signal which are not used for video signal transmission.

8. An arrangement for receiving data packets accommodated in video lines of a television signal, comprising a quadrature amplitude demodulator (61) for demodulating said data packets.

9. A television signal comprising data packets in lines of the television signal which are not used for video transmission, characterized in that said data packets are quadrature amplitude-modulated, using a predetermined carrier frequency which is located within the baseband video bandwidth of said television signal.

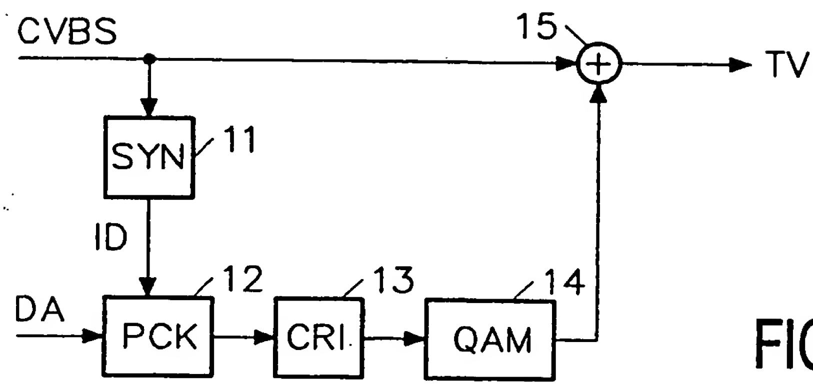

FIG. 1

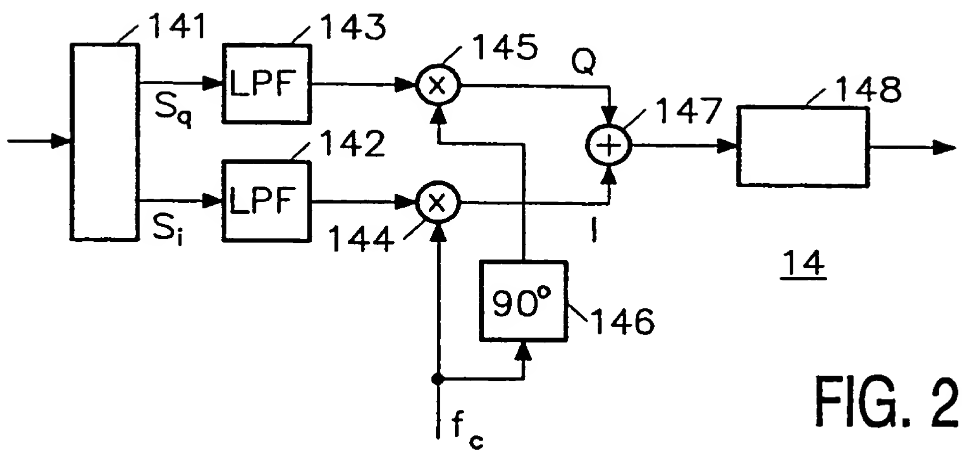

FIG. 2

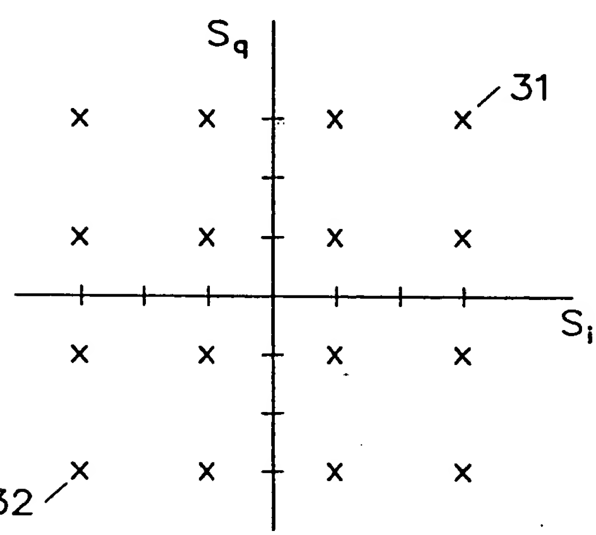

FIG. 3

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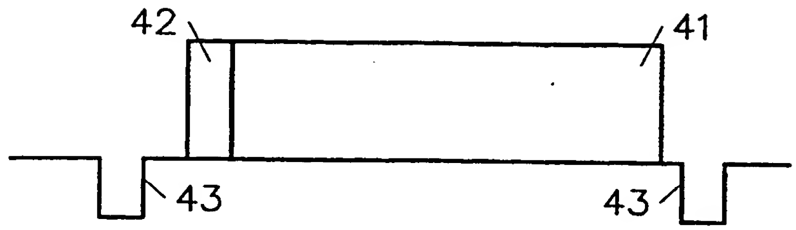

FIG. 4

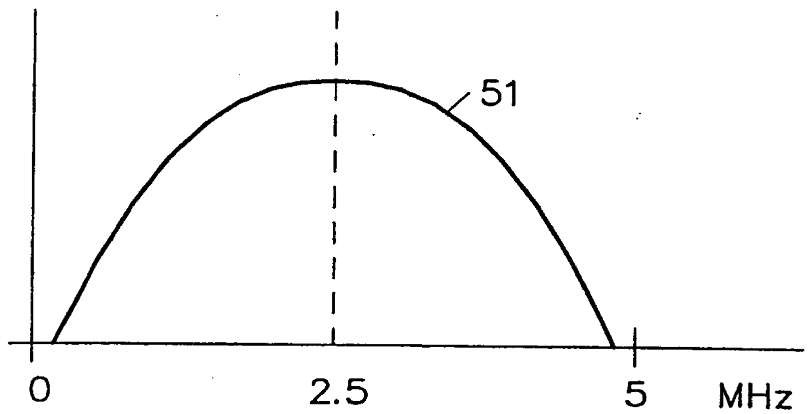

FIG. 5

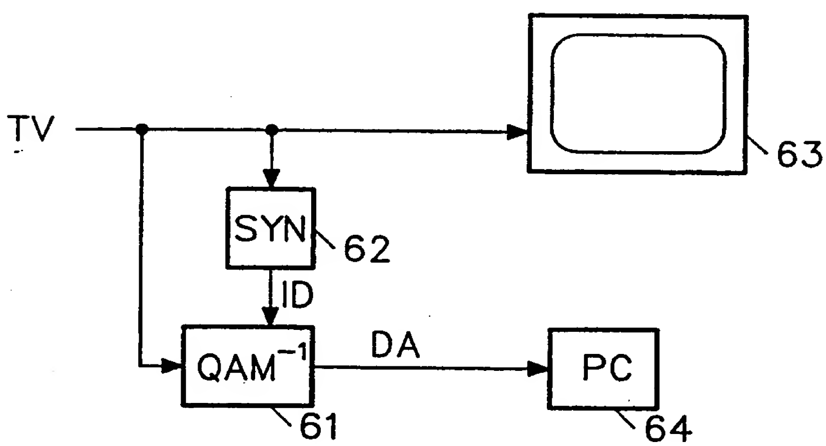

FIG. 6

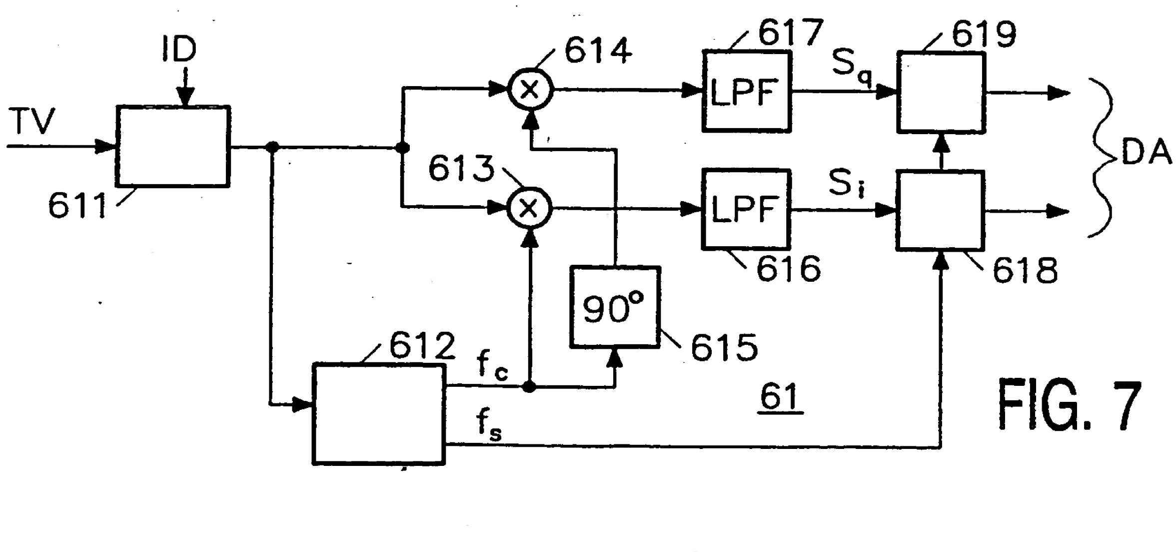

FIG. 7

INTERNATIONAL SEARCH REPORT

Intern. ıal Application No
PCT/EP 99/09204

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 H04N7/081 H04N7/088

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 H04N

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

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C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X A	DE 195 44 582 A (DEUTSCHE TELEKOM AG) 5 June 1997 (1997-06-05) page 2, line 28 - line 30 page 4, line 40 - line 60; figure 4 ---	1,2,4-9 3
X	US 5 309 235 A (NAIMPALLY SAIPRASAD V) 3 May 1994 (1994-05-03) column 2, line 63 -column 3, line 22; figure 1 figure 4 column 5, line 53 - line 62; figure 6 -----	1,2,4-9

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Date of the actual completion of the international search	Date of mailing of the international search report
10 April 2000	17/04/2000

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Information on patent family members

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Patent document cited in search report	Publication date	Patent family member(s)	Publication date
DE 19544582 A	05-06-1997	NONE	
US 5309235 A	03-05-1994	JP 2694221 B	24-12-1997
		JP 6225341 A	12-08-1994

Form PCT/ISA/210 (patent family annex) (July 1992)